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GB 2154349 A **EP 0536554 A** **US 5404458 A**
US 5059959 A

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(54) Display driver

(57) A display driver suitable for use with touch sensitive displays, and responsive to a wiping motion across the touch sensitive display, is disclosed. Upon detecting a wiping motion across a touch sensitive display the display driver responds by displaying a subsequent page of information which is in sequential correspondence with the page of information displayed when the swipe motion was made. Criteria for determining whether or not a swipe or wiping motion is intended or not are disclosed, and there is provided a description of a flow chart for a method of operation suitable for implementation via a micro-processor. The touch sensitive displays may be used in hand held devices such as mobile telephones.

GB 2 301 217 A

Fig.1.

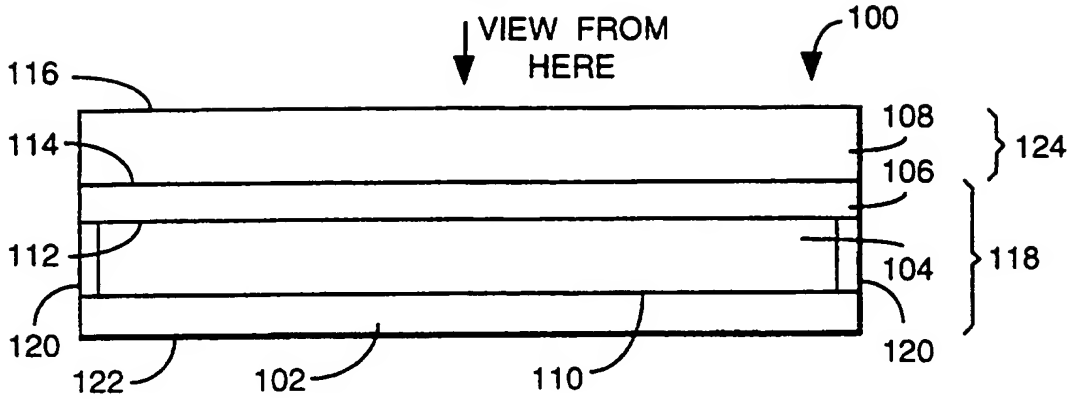


Fig.2A.

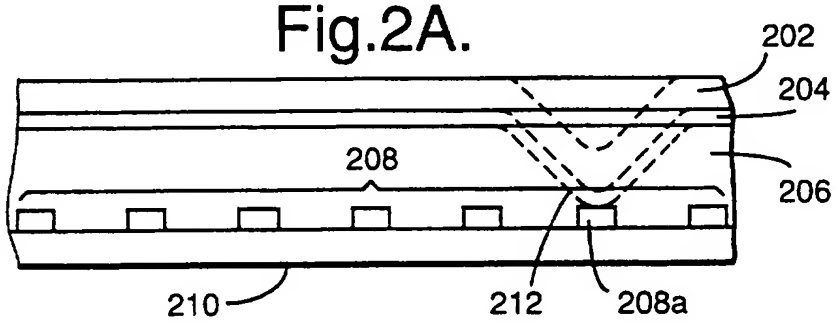


Fig.2B.

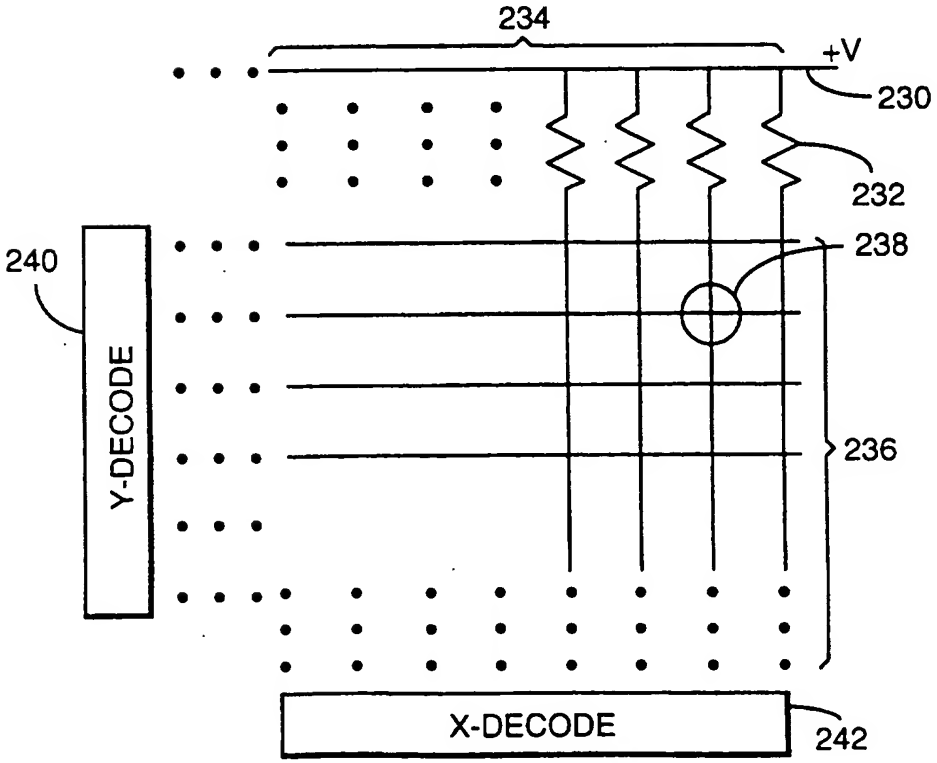


Fig.3.

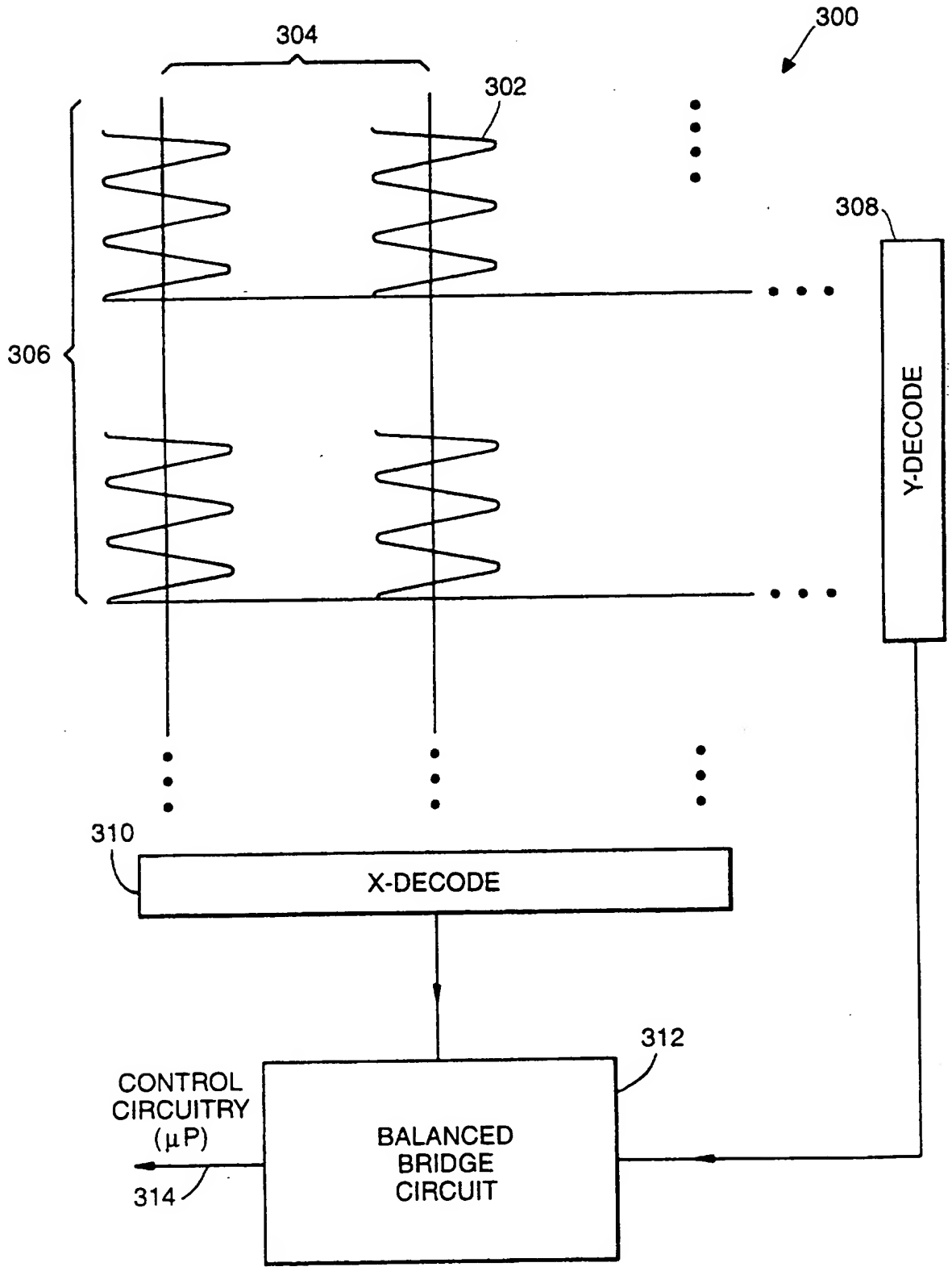

300
304
302
308
306
Y-DECODE
310
X-DECODE
312
CONTROL
CIRCUITRY
(μP)
314
BALANCED
BRIDGE
CIRCUIT

Fig.4.

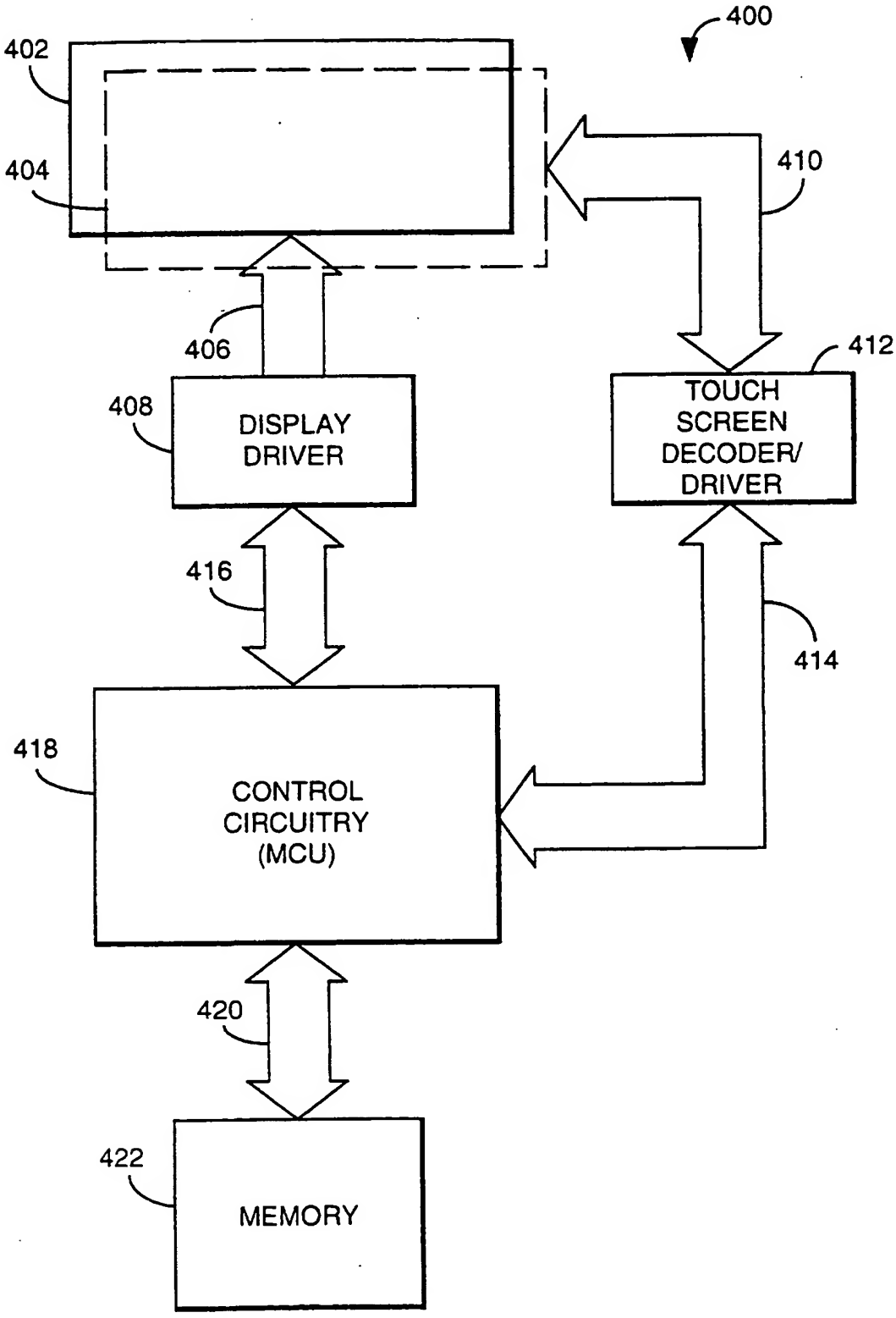

400
402
404
410
406
412
408
DISPLAY DRIVER
TOUCH SCREEN DECODER/ DRIVER
416
414
418
CONTROL CIRCUITRY (MCU)
420
422
MEMORY

Fig.5A.

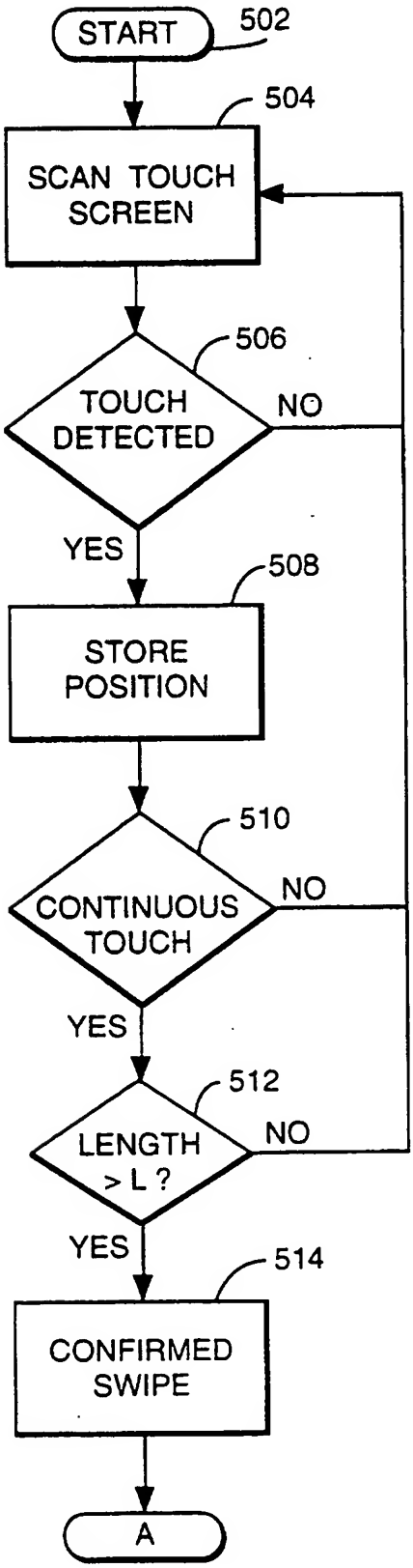
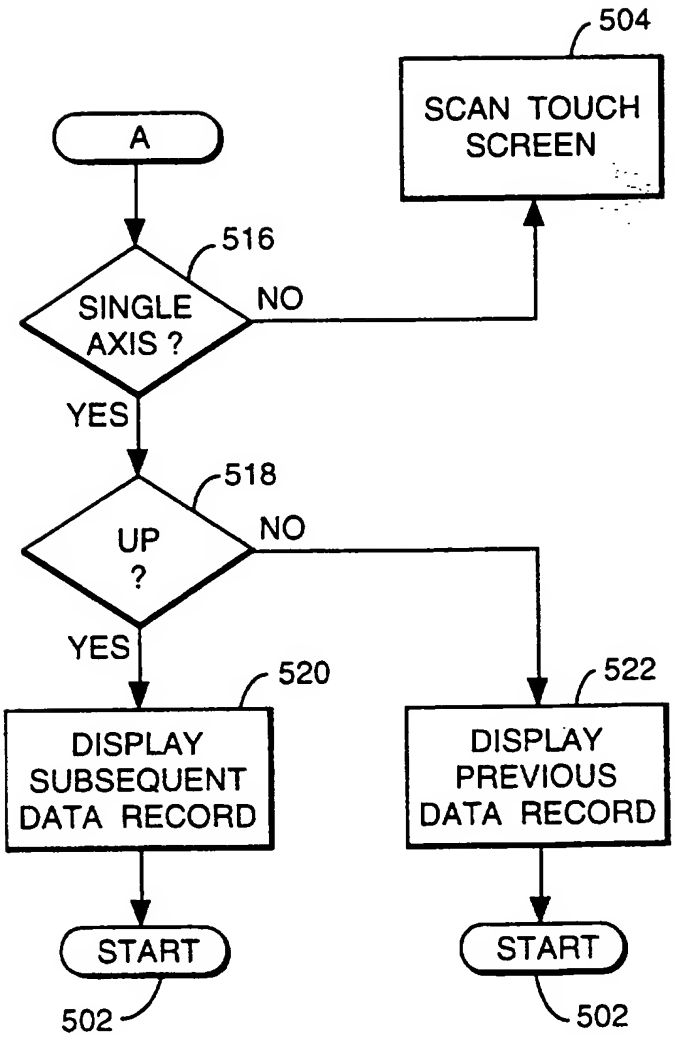

START
502
504
SCAN TOUCH SCREEN
506
TOUCH DETECTED
NO
YES
508
STORE POSITION
510
CONTINUOUS TOUCH
NO
YES
512
LENGTH > L ?
NO
YES
514
CONFIRMED SWIPE
A

Fig.5B.


504
SCAN TOUCH SCREEN
A
516
SINGLE AXIS ?
NO
YES
518
UP ?
NO
YES
520
DISPLAY SUBSEQUENT DATA RECORD
522
DISPLAY PREVIOUS DATA RECORD
START
502
START
502

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DISPLAY DRIVER

The present invention relates to a display driver. In particular, but not exclusively, to a display driver for touch sensitive displays for hand held electronic devices such as palm top computers or organisers, and portable radio telephones.

Touch sensitive displays are well known, and can be split into two basic types. The first type are those that require the display to be touched with a force sufficient to deform the display, or a screen over the display, in the region where the display was touched in order for control circuitry associated with the display to respond to the touch. The second type comprises those which merely require a light touch or the mere presence of a stylus or finger close to the screen in order for the touch sensitive screen to respond. The term "touch sensitive" is intended to encompass display screens requiring actual mechanical contact and those where the mere presence of a stylus or finger causes the control circuitry for or associated with the touch sensitive screen to respond.

A side view of a typical known touch sensitive display 100 is shown in Figure 1. The display is a Liquid Crystal Display (LCD) 118 and comprises opposing glass or plastics transparent plates 102, 106 separated by spacers 120 and having a liquid crystal material 104 disposed between them. On the inner faces 110, 112 of respective glass plates 102, 106 adjacent to the liquid crystal material 104 are disposed electrodes for activating the liquid crystal material 104 thereby forming displayed information. The LCD may be a reflected light display having a reflector disposed adjacent face 122 of glass plate 102, or an illuminated display having a light source disposed adjacent face 122. A touch sensitive screen 124 is disposed on the face of the display 118 closest to a user. The touch sensitive screen 124 comprises an insulator 108 having electrodes disposed on opposing surfaces 114, 116 thereof. The electrodes are arranged in a matrix fashion to form a grid, thereby dividing the screen 124 and hence display 118 into regions.

Conventionally, touch sensitive screens have been used in conjunction with display screens to provide "soft" keyboards. Icons or function labels are displayed on the display, and when a region of a touch sensitive screen disposed over the display and corresponding to an icon or function label is activated electronic apparatus associated with the display, such as a computer, performs the function corresponding to the said icon or label. In some applications, particularly those with small screens, it is necessary to use a thin stylus instead of a finger to obtain the resolution necessary to distinguish between different regions of the display corresponding to respective icons or labels. This can be inconvenient, particularly since the stylus can easily get lost.

In accordance with a first aspect of the present invention there is provided a display driver, comprising detection means responsive to a wipe movement on a touch sensitive pad for displaying next information sequentially corresponding to information displayed prior to the wipe movement on a display associated with the touch sensitive pad; and in accordance with a second aspect of the present invention there is provided a method of driving a display, comprising the steps of detecting a wipe movement on a touch sensitive pad associated with a display, and displaying next information sequentially corresponding to information displayed on the display prior to the wipe movement.

An advantage of the present invention is that information which is typically displayed sequentially, such as database records or menu screens, can be displayed for review or inspection without requiring depression of particular keys on a key pad or key board. The wipe movement or stroke can be similar to the finger or thumb movement typically used to flick through pages of a conventional bound diary, or address book, or a Rolodex file. Thus, users of an electronic device incorporating an embodiment in accordance with the invention who might be unfamiliar or intimidated with conventional modes of operating such devices can use a familiar movement or technique to search through similar types of information contained in screen pages displayed on the display of the electronic device.

Furthermore, because the motion is a wipe movement problems with resolution are obviated.

In a preferred embodiment of the invention the touch sensitive pad is a transparent screen disposed over the display. This has the advantage that a separate region for the touch sensitive screen does not have to be provided, which is particularly useful for small devices since it reduces the size of the electronic device. Furthermore, there is further correspondence with familiar finger and thumb search movements since the actual wipe movement takes place on the " page" of information displayed, much as when diary or address book pages are flicked through to find a particular entry.

Preferably, the detection means is responsive to a wipe movement comprising a substantially continuous coupling to the touch sensitive pad for a predetermined distance across the touch sensitive pad, which advantageously inhibits spurious responses to unintentional touching of the touch sensitive pad. Optionally, the detection means is only responsive to a wipe movement in substantially one axis across the touch sensitive pad, which has similar advantages to those described above. Typically, single axis movements may be up or down, or left to right of the display as viewed by a user.

Suitably, the detection means is responsive to wipe movements in substantially opposing directions to respectively display preceding next or succeeding next information which facilitates moving forwards and backwards through data records or menu screens.

Specific embodiments in accordance with the invention will now be described, by way of example only, and with reference to the accompanying drawings, in which:
Figure 1 shows a conventional touch sensitive display structure;
Figure 2A shows a cross-section of a wire grid touch sensitive screen;
Figure 2B shows a schematic diagram of the drive and decode circuitry for a wire grid touch sensitive screen;

Figure 3 shows a schematic diagram of the drive and decode circuitry for a non-contact touch sensitive screen;

Figure 4 shows apparatus in accordance with an embodiment of the invention; and

Figure 5 shows a flow chart for an appropriately conditioned microcontroller for implementing a second embodiment in accordance with the invention.

Figures 2 and 3 show two different electrode structures typically found in touch sensitive screens. Figure 2A shows a cross-section of a wire grid touch sensitive screen 200. Transparent insulating plates 202 and 210 are disposed opposing each other and have electrodes 204 and 208 disposed on inner faces of respective plates and oriented transverse to each other thereby forming a wire grid. Insulator 206 disposed between the plates 202, 210 and the transverse electrodes 204, 208 is typically fluid such that pressure on a plate 202, 210 causing the plate to deform moves the insulating material 206 to permit electrodes to touch, e.g. 204 and 208a as shown by the dotted lines 212. Plates 202, 210 may be fabricated from plastics or other suitable insulating material in order to allow them to deform in the manner shown by dotted line 212. A schematic diagram of the electrical connections for a wire grid touch sensitive screen is shown in Figure 2B. X axis positions are derived from vertical wires 234 which are respectively coupled via resistors 232 to a power supply line 230 (+V). The wires 234 are coupled to an X-decoder circuit 242. Horizontal wires 236 are used for Y-decoding and are coupled to Y-decoder 240.

The intersection of two wires 238 due to touching of the screen 200 in that region can be detected in a manner well known from the key pad art. The Y lines 236 which are normally floating high, are sequentially grounded by Y-decoder 240 whilst the X-decoder scans the X lines 234 for any short circuits for respective grounding of Y lines 236. When an X-decode input is grounded since the control circuitry recognises or knows which Y line is grounded the exact location of the touching of X and Y lines may be determined.

An alternative touch sensitive display 300 is shown in Figure 3. Similar elements in Figure 3 to those in Figure 2 are given similar reference numerals as those in Figure

2. This display is responsive to a change in capacitance due to the proximity of a stylus or finger to a region of the display 300. The stylus or finger does not have to be in mechanical contact with the touch sensitive display 300. The vertical X-lines 304 are mere wire conductors disposed on a supporting plate 202. Horizontal Y-lines 306 comprise convoluted sections of conductor 302 regularly disposed over a plate 210 disposed opposing plate 202, to define distinct regions. Each position on the X-Y grid defined by X and Y lines 304, 306 is decoded in a similar manner to that described for display 200, using X-decoder 310 and Y-decoder 308. However, each pair of X-Y scanned lines forms an arm of balanced bridge circuit 312 in order to determine whether there is a change in capacitance from the "untouched" or non-perturbed state. The result from the balanced bridge circuit 312 is sent to control circuitry 314 which is typically a microcontroller unit or microprocessor to determine whether a region of the display has been touched. The balanced bridge circuit 312 may be any known bridge capable of detecting changes in capacitance.

Apparatus 400 in accordance with an embodiment of the invention is shown in Figure 4. A display screen 402 has disposed over it a transparent touch sensitive screen 404. For the sake of clarity the display screen 402 and touch sensitive screen 404 are shown offset relative to each other, and the touch sensitive screen 404 is shown in dotted outline.

The display screen 402 is coupled by control bus 406 to a display driver 408 which controls display screen 402. The touch sensitive screen 404 is coupled to decode/drive circuitry 412 by bus 410. Both the display driver 408 and touch sensitive decode/drive circuitry 412 can be conventional circuitry typically supplied as integrated circuits. The display screen 402 and touch sensitive screen 404 may also be conventional devices. A particularly suitable touch screen 404 is that described earlier with reference to Figure 3 of the drawings. Such a touch screen is sensitive to changes in capacitance and does not require physical contact with it to respond. Thus, the screen of Figure 3 can be kept clean and relatively free of contamination typically occurring when a screen is touched. Furthermore, a firm mechanical pressure on the touch screen of Figure 3 is not required, only a mere

brushing at most, which makes the touch screen of Figure 3 particularly suitable for handheld devices since they do not need to be held firm.

The display driver 408 is coupled to control circuitry 418 by bus 416. The control circuitry 418 performs and outputs all the usual functions and signals known to a skilled person to cause information to be displayed via the display driver 408 on the display 402. Touch screen decoder/driver 412 is coupled to control circuitry 418 via bus 414. Touch screen decoder/driver 412 inputs to the control circuitry 418 information corresponding to whether the touch sensitive screen 404 has been touched and the position on the screen 404 corresponding to the touching. The control circuitry 418 is also coupled to a memory 422 via bus 420. The control circuitry 418 is capable of taking data stored in the memory 422 and causing it to be displayed on the display screen 402 via display driver 408, in response to signals received from the touch screen decoder/driver 412. The control circuitry 418 may be discrete logic, medium scale integrated logic or an appropriately conditioned microcontroller unit (MCU). Typically, a MCU 418 would also control other functions of an electronic device associated with the display 402, such as key board functions. Additionally, both or one of the display driver 408 and touch screen decoder/driver 412 may be comprised within the MCU 418.

A method of operating a microcontroller unit 418 in accordance with an embodiment of the invention is shown in Figure 5. The method starts at step 502 and the touch screen is scanned at step 504. At each grid point of the touch screen interrogated during scanning a test is carried out at step 506 by the MCU 418 to determine if the screen has been touched at that grid point. If no touch was detected then the method returns to step 504 and scanning of the screen continues. If a touch was detected then the position of that touch on the screen is noted and stored at step 508. Then it is determined at step 510 whether or not the instant touch forms part of a substantially continuous touch. Whether or not a touch is part of a substantially continuous touch can be tested with reference to empirical data, for example that is to say, a number of wipe movements can be made during a design phase of apparatus embodying the invention to see how often the wiping stylus or finger

loses contact with the touch screen during what a test user intended to be a definite wipe. Such data would set a criteria of a maximum number of times, and for what distance, contact can be lost with the touch screen whilst still being determined a definite wipe movement. If it is determined that there is no continuous touch then the method returns to step 504 and the scanning of the touch screen resumes. However, if it is determined that the instant touch does form a part of a continuous touch, i.e. fulfills the criteria discussed above, then the method proceeds to step 512, where it is determined whether or not the continuous touch exceeds a predetermined distance across the touch screen. If not, then the method returns to step 504 and scanning of the touch screen is resumed, but if yes then a confirmed wipe is recorded at step 514. It is then determined at step 516 whether or not the wipe occurred along substantially a predefined single axis. In the present embodiment the axis has been defined as transverse to the direction of text display on the display screen, i.e. in the vertical direction for conventional displays. If it is determined that the confirmed wipe was not substantially along a vertical axis then the method returns to step 504 and scanning of the touch screen resumes. If the confirmed wipe was substantially along the vertical axis then it is determined at step 518 whether or not the wipe was up or down. If the wipe was in an up direction then the subsequent data record is displayed 520, and if in the down direction the previous data record is displayed 522. After displaying the next data record the method returns to the start 502.

The above described apparatus and method are particularly useful for searching through electronic address books or other databases where the data records are sequential, i.e. alphabetically stored. Each time a confirmed up or down wipe is determined the subsequent or previous address can be displayed on the display. Similarly for menu screens or telephone directories.

In view of the foregoing description it will be evident to a person skilled in the art that various modifications may be made within the scope of the invention. For example, any touch sensitive screen can be used in an embodiment of this invention, and the touch sensitive screen does not have to be placed over the display.

Additionally, the defined axis can be from left to right across a screen, with the particular direction resulting in a forward or backward progression through the stored data records. For the avoidance of doubt, the term "touch sensitive" includes screens where it is not necessary to mechanically contact the screen to activate it.

The scope of the present disclosure includes any novel feature or combination of features disclosed therein either explicitly or implicitly or any generalisation thereof irrespective of whether or not it relates to the claimed invention or mitigates any or all of the problems addressed by the present invention. The applicant hereby gives notice that new claims may be formulated to such features during prosecution of this application or of any such further application derived therefrom.

CLAIMS

1. A display driver, comprising detection means responsive to a wipe movement on a touch sensitive pad for displaying next information sequentially corresponding to information displayed prior to the wipe movement on a display associated with the touch sensitive pad.

2. A display driver according to claim 1, wherein the touch sensitive pad is a transparent touch sensitive screen disposed over the display means.

3. A display driver according to claim 1 or claim 2, wherein the detection means is responsive to a wipe movement comprising a substantially continuous coupling to the touch sensitive pad for a predetermined distance across the touch sensitive pad.

4. A display driver according to any preceding claim, wherein the detection means is only responsive to a wipe movement in substantially one axis across the touch sensitive pad.

5. A display driver according to claim 4, wherein the detection means is responsive to wipe movements in substantially respective opposing directions to respectively display preceding or succeeding next information.

6. A display driver substantially as hereinbefore described and with reference to respective embodiments shown in the drawings.

7. A method of driving a display, comprising the steps of detecting a wipe movement on a touch sensitive pad associated with a display, and displaying next information sequentially corresponding to information displayed on the display prior to the wipe movement.

8. A method according to claim 7, further comprising detecting a wipe movement comprising a substantially continuous coupling to the touch sensitive pad for a predetermined distance across the touch sensitive pad.

9. A method according to claim 7 or claim 8, further comprising detecting only a wipe movement in substantially one axis across the touch sensitive pad.

10. A method according to claim 9, yet further comprising detecting wipe movements in substantially respective opposing directions to respectively display preceding or succeeding next information.

11. A method substantially as hereinbefore described and with reference to Figure 5 of the drawings.